We Claim:

1. A method of continuously generating combustion products from a fuel-rich reactant mixture, the method comprising:

(a) flowing the reactant mixture through a heated zone of a reactor, the reactor containing a porous fixed-bed and operating at a temperature sufficient to result in a superadiabatic combustion of the reactant mixture; and,

(b) combusting the reactant mixture in the heated zone to generate the combustion products and heat, the heat being sufficient to maintain the operating temperature of the heated zone for the superadiabatic combustion of additional reactant mixture.

2. The method of claim 1 wherein the reactant mixture comprises oxygen and one or more C_1 to C_5 hydrocarbons.

3. The method of claim 1 wherein the combustion products comprise hydrogen, carbon dioxide, and one or more C_1 to C_5 hydrocarbons.

4. The method of claim 3 wherein the hydrocarbon comprises ethylene, propylene, butylene, acetylene, or mixtures thereof.

5. The method of claim 1 wherein the operating temperature of the heated zone is about 800°C to about 2500°C.

6. The method of claim 5 wherein the operating temperature of the heated zone is about 1000°C to about 1700°C.

7. The method of claim 1 wherein the reactant mixture has an equivalence ratio of hydrocarbon to oxygen of greater than about 1.2 to about 20.

8. The method of claim 1 wherein the equivalence ratio is about 2.5 to about 15.

9. The method of claim 8 wherein the equivalence ratio is about 3 to about 10.

10. The method of claim 1 wherein the reactor is operated at an internal pressure of about 0.1 atmospheres to about 100 atmospheres.

11. The method of claim 10 wherein the reactor is operated at an internal pressure of about 1 atmosphere to about 100 atmospheres.

12. The method of claim 1 wherein the fixed-bed has a porosity sufficient to allow gas flow therethrough.

13. The method of claim 12 wherein the fixed-bed has a porosity of about 10% to about 90%.

14. The method of claim 12 wherein the fixed-bed comprises pellets made from a material selected from the group consisting of alumina, silicon carbide, silicon nitride, and quartz.

15. The method of claim 14 wherein the pellets have a diameter of about 0.05 millimeters (mm) to about 10 mm.

16. The method of claim 12 wherein the porous material comprises about 0.001 weight percent (wt.%) to about 10 wt.% of a catalyst.

17. The method of claim 1 wherein the heat is a transient thermal wave.

18. The method of claim 17 wherein the thermal wave is coupled to the flow of the reactant mixture.